

Pacific Halibut Discard Mortality Rates in the 1990-2001 Alaskan Groundfish Fisheries, with Recommendations for Monitoring in 2003

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Abstract

Results from analysis of halibut release condition and injury data collected in the 2001 groundfish fisheries, both open access and Community Development Quota fisheries, are presented. No recommendations are proposed for changes to DMRs used in the open access fisheries, following the plan adopted in 2000 for using a 10-year average DMR for those fisheries for a 3-year period. This is the last of the current 3-year cycle. Recommendations for 2004-2006 will be presented next year. Recommendations are provided for 2003 CDQ trawl, longline and pot operations.

Introduction

Pacific halibut discard mortality rates (DMRs) in the Alaskan groundfish fisheries are estimated from viability data collected by National Marine Fisheries Service (NMFS) observers. Analysis by staff of the International Pacific Halibut Commission (IPHC) results in recommendations to the North Pacific Fishery Management Council (NPFMC or Council) for managing halibut bycatch in the upcoming season. This paper describes the results from an analysis of data collected from the 2001 fishery and includes DMR recommendations for 2003 Community Development Quota (CDQ) fisheries, as follows:

CDQ Trawls

Atka mackerel: 0.80
Bottom pollock: 0.90
Flathead sole: 0.90
Pelagic pollock: 0.89
Rockfish: 0.90
Yellowfin sole: 0.83

CDQ Longlines

Pacific cod: 0.11
Turbot: 0.04

CDQ Pots

Pacific cod: 0.02
Sablefish: 0.46

Data Used and Methods

Observer haul-by-haul data from the NMFS NORPAC data base were used for this analysis. The data records included the catch of groundfish by species or species group, estimates of the number and weight of halibut bycatch, and the number and length of halibut sampled for release viability or injury by category (excellent/poor/dead for trawls and pots, minor/moderate/severe/dead for longlines). Records for all hauls sampled by observers in 2001 were obtained and appended to data currently on hand for 1990-2000. Hauls not sampled for species composition were excluded.

The first task was to partition the records into target fishery categories, which was accomplished through a "retained catch" approach, using the catch composition for sampled

hauls summed during a reporting week. The target is then assigned based on the percentage of particular species within the weekly catch composition (Williams 1997).

The targeting determination was based on a series of assumptions about the total catch and retained catch within a reporting week. Midwater pollock hauls were split out if that species comprised 95% of the total catch. A similar approach was used for an Arrowtooth flounder target in the Gulf of Alaska (GOA), but the assignment was made at 65% of the total catch. The determination for the remaining targets assumes that all arrowtooth flounder caught in a haul were discarded; the remaining species are assumed retained. Target determination was based on the species/species group comprising the greatest percentage of the “retained” catch. Flatfish targets in the Bering Sea/Aleutian Islands (BSAI) were determined in a succession of comparisons of individual flatfish species compositions in the catch. Table 1 shows the target codes and definitions used in this analysis.

The approach was modified slightly for CDQ fisheries. Because of the nature of the CDQ operations, vessels can potentially move from one target to another on every haul, rendering a “weekly” approach meaningless. So a target was assigned to each haul, using the same species composition criteria employed for open access fisheries.

NMFS observers examine halibut for the release viability or injury upon return to the sea. Each fish is judged according to a set of criteria (Tables 2-4), which are used to determine internal and external injuries, and body damage from predators (e.g., sand fleas and others). Beginning in 2000, a dichotomous key was provided to reduce subjectivity in the determinations of condition. Observers record the number of excellent, poor and dead condition (trawls and pots) or minor, moderate, severe, and dead (longlines) halibut for each haul/set sampled. Viability samples are only collected on hauls sampled for species composition. The species composition sampling provides an estimate of the total number of halibut caught in the haul, as well as the catch of groundfish, necessary for determining the target. Observers are instructed to limit the number of fish examined to a maximum of 20, although this is occasionally exceeded by enthusiastic observers.

Next, the viability distribution is calculated. First, for each haul, the proportion of halibut in each category is extrapolated up to the total number of halibut caught. The extrapolated numbers of excellent, poor, and dead halibut are then summed within each region/gear/target strata.

The general model for calculating the DMR for halibut caught by gear g is of the form:

$$DMR_g = \sum_{i=1}^4 (m_{i,g} \times P_i)$$

where m is the mortality rate for gear g , and P is the proportion of halibut in condition i , where 1 is excellent/minor, 2 is poor/moderate, 3 is dead/severe, and 4 is dead.

The mortality rate m varies among gear types (see Clark et al. (1992) for trawls, Williams (1996) for pots, and Kaimmer and Trumble (1998) for longlines) and represent the aggregate effects of external and internal injuries to the fish and the presence of predation by amphipods or marine mammals. There can be many sources of injuries, which vary by gear type. For longlines, injuries are most frequently caused by improper release methods used by vessel crews. Other significant factors include the length of the soak time, which can exacerbate the mortality caused by hooking injuries and also increase the potential for amphipod predation. Halibut mortality rates by gear and condition/injury are shown in the following table:

Gear (g)	m_{exc}	m_{poor}	m_{dead}	
Trawl	0.20	0.55	0.90	
Pot	0.00	1.00	1.00	
	m_{minor}	m_{moderate}	m_{severe}	M_{dead}
Longlines	0.035	0.363	0.662	1.00

Mean fishery DMRs and associated standard errors have been estimated by assuming that each vessel was a separate sampling unit, enabling a DMR to be calculated for each individual vessel in a target fishery. The DMR for a target fishery is then estimated as the mean of vessel DMRs, where the vessel's proportion of the total number of bycaught halibut is used as a weighting factor as follows:

Let DMR_v = observed DMR on vessel v
 p_v = proportion of total number of halibut caught on vessel v in a fishery

$$\text{Then } \overline{DMR} = \sum_{v=1}^n (p_v \times DMR_v)$$

Standard errors of the weighted mean DMR were estimated as:

$$V(\overline{DMR}) = \sum_{v=1}^n (p_v^2 \times V(DMR_v))$$

and $SE(\overline{DMR}) = \sqrt{V(\overline{DMR})}$

where $V(DMR_v)$ is the sample variance of all the DMR_{s_v} , and $V(\overline{DMR})$ and $SE(\overline{DMR})$ are the variance and standard error of \overline{DMR} , respectively.

Results for 2001 Fisheries

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The number of halibut examined by observers in a single fishery was, in most cases, substantial. For example, slightly more than 14,000 fish in the BSAI pelagic pollock fishery and close to 20,000 fish in the BSAI cod hook-&-line fishery were examined by observers (Table 5). Six of 11 BSAI trawl fisheries had sample sizes greater than 1,000 fish. In contrast, only one out of three hook-&-line fisheries (BSAI cod) had more than 1,000 halibut sampled. The GOA fishery with the largest number of halibut examined was trawl cod (over 3,400 fish). Shallow water flatfish and rockfish trawl had approximately 2,200 and 1,200 halibut examined, respectively. All other GOA fisheries had less than 1,000 fish examined, and all but three had more than 300 halibut examined.

Table 6 reports the on the viability/injury strata sample sizes and resulting DMRs calculated in the analysis. In general, the DMRs are consistent with results seen in past analyses. Trawl fishery DMRs ranged from 0.50 to 0.90, with DMRs generally higher in the BSAI. Longline fishery DMRs ranged from 0.12 to 0.16. Pot fisheries for cod generally exhibit lower

DMRs than longline or trawl, typically less than 0.10. However, the 2001 GOA pot fishery was substantially higher (0.33) than is normally seen in this gear type.

In general, BSAI trawl fishery DMRs exhibited no overall increase or decrease; results were mixed when compared to 2000 estimates. For the BSAI, decreases were noted for atka mackerel (0.77 in 2000 to 0.73 in 2001), rockfish (0.89 to 0.85), flathead sole (0.74 to 0.69), turbot (0.74 to 0.68) and yellowfin sole (0.77 to 0.74). All others increased or were unchanged.

In the GOA, results were also mixed, as five trawl fisheries declined and five increased. Decreases were seen in the four flatfish targets (shallow water, deep water, flathead and rex) and the rockfish target, whereas increases occurred in the cod, pollock, sablefish and Arrowtooth targets.

The 2001 longline fishery DMRs showed only minor change from 2000. The BSAI cod fishery DMR was unchanged from 2000, remaining at 0.12. Since 1996 the BSAI cod fishery has maintained its DMR at 0.11-0.12, which probably reflects the inherent DMR level in major longline fisheries. Other longline targets occasionally go below this level, but are usually small fisheries with only a few vessels involved. For a major fishery like cod, with upwards of 40 vessels fishing annually, stability in a halibut DMR reflects fleet-wide efforts to minimize halibut release injuries. The GOA longline cod fishery also was measured at 0.11 in 2001, matching the level achieved in three of the previous 10 years.

Pot fishery DMRs exhibited large changes from 2000. In the BSAI fishery, the DMR dropped to 0.06, almost half of the 2000 value and a level typically shown by this gear type. In contrast, the GOA fishery displayed a substantial increase in its DMR in 2001, up to 0.33. This is the highest level achieved by any pot fishery since these DMR analyses were initiated by IPHC in 1990. These results for the 2001 GOA fishery appear to possibly reflect changes made to management of the cod fishery itself, in that directed cod fishing was curtailed during 2001 in response to the need for Steller sea lion protection. The possible impacts would include moving vessels to areas with low or 'scratch' cod catch rates, causing higher than normal soak times which would result in high mortality. A second hypothesis is that many of the experienced pot vessels chose not to participate in 2001 because of other opportunities or the complications presented by the sea lion protection measures. Observer data show that while 41 vessels were observed in 2000, just 21 were observed in 2001 (Table 5) or roughly half the effort in 2001 compared to 2000.

CDQ Fisheries

A summary of observer coverage, sampling, and halibut viability data is shown in Table 7. In 2001 pot, trawl, and longline gear was used in CDQ fishing. Applying the target algorithm on the haul species composition resulted in hauls being identified for all possible targets. However, the majority of data were collected on trawl hauls targeting pollock (pelagic), longline sets targeting cod, and pot hauls for sablefish.

For most trawl targets, almost all halibut were dead when examined, a pattern fairly indicative of pelagic pollock fishing. Only atka mackerel and other flatfish resulted in a DMR lower than 0.90.

Longline CDQ fishing in 2001 consisted primarily of cod fishing, with a small amount of effort directed towards sablefish. Very little halibut data were collected from the non-cod targets. Distribution of halibut injuries in the CDQ longline cod fishery was similar to that observed in the open access cod fishery, resulting in the same DMR for the CDQ fishery (0.11).

Pot effort in 2001 was split between cod and sablefish, although not many data were collected from cod fishing. Halibut DMRs were significantly different between these fisheries. Cod fishery DMR was quite low (0.02), even lower than in the open access pot cod fishery. Sablefish pot fishery DMRs were much higher (0.46), reflecting the greater depths of the fishery and the greater inherent mortality potential from those fishery conditions.

Recommendations for Preseason Assumed DMRs for 2003

Since 1993, Preseason Assumed DMRs have been adopted for an upcoming season based on trends in DMR data from prior years. In 2001 we proposed, and the Council adopted, a plan to use the 10-year average DMR for all open access fisheries. Therefore, we will not be submitting any recommendations for changing the DMRs in these fisheries. The historical set of DMRs by gear and fishery for the BSAI and GOA are shown in Tables 7 and 8, respectively, for information only. We will continue to annually examine the CDQ fisheries and provide recommendations for any appropriate DMR revisions for those fisheries only.

CDQ Fisheries

As in 2000, CDQ trawl effort in 2001 was focused primarily on pollock; effort at other targets was apparently very low, as very few vessels were determined to be in other targets and few halibut were examined in all but pollock. We recommend that the 2003 CDQ trawl fisheries use the 2001 CDQ trawl DMRs shown in Table 9, with any remaining targets that develop in 2003 using the open access long-term averages found in Table 9.

CDQ longline fishing in 2001 was directed primarily at cod and resulted in a DMR of 0.11 (Table 9). We recommend that this DMR be used in 2003. As with trawls, too few halibut were examined to provide meaningful results for the other targets. Longline targets other than cod should use the open access long-term DMRs shown in Table 9.

Pot fishery DMRs for cod and sablefish fishing were 0.02 and 0.46, respectively. We recommend these DMRs be used for 2003 monitoring. Pot fishery targets other than cod that develop in 2003 should use the cod fishery DMR until data from these fisheries can be collected and analyzed, and DMRs identified.

References

Clark, W. G., Hoag, S. H., Trumble, R. J., and Williams, G. H. 1992. Re-estimation of survival for trawl caught halibut released in different condition factors. *Int. Pac. Halibut Comm. Report of Assessment and Research Activities 1992*: 197-206.

Kaimmer, S. M., and Trumble, R. J. 1998. Injury, condition, and mortality of Pacific halibut bycatch following careful release by Pacific cod and sablefish longline fisheries. *Fish. Res.* 38(2):131-144.

Williams, G. H. 1996. Pacific halibut discard mortality rates in the 1994 Alaskan groundfish fisheries, with recommendations for monitoring in 1996. *Int. Pac. Halibut Comm. Report of Assessment and Research Activities 1996*: 173-183.

Williams, G. H. 1997. Pacific halibut discard mortality rates in the 1990-1995 Alaskan groundfish fisheries, with recommendations for monitoring in 1997. *Int. Pac. Halibut Comm. Report of Assessment and Research Activities 1997*: 211-227.

Table 1. 2001 groundfish target definitions and target determination method used to classify NORPAC hauls in the halibut viability and discard mortality rate analysis.

BSAI		GOA	
Target	Definition	Target	Definition
A	Atka mackerel	A	Atka mackerel
B	Bottom pollock	B	Bottom pollock
C	Pacific cod	C	Pacific cod
F	Other flatfish	D	Deep water flatfish
K	Rockfish	H	Shallow water flatfish
L	Flathead sole	K	Rockfish
O	Other spp.	L	Flathead sole
P	Pelagic pollock	O	Other spp.
R	Rock sole	P	Pelagic pollock
S	Sablefish	S	Sablefish
T	Greenland turbot	W	Arrowtooth flounder
Y	Yellowfin sole	X	Rex sole

OPEN ACCESS and CDQ TARGET DETERMINATION

Bering Sea/Aleutians

- P** if Pollock $\geq 95\%$ of total catch, or
- Y/R/L/F** if (rock sole + other flatfish + yellowfin sole + flathead) is the largest component of the retained catch using this rule:
- Y** if yellowfin sole is $\geq 70\%$ of (rock sole + other flatfish + yellowfin sole + flathead sole), or
- R** if rock sole > other flatfish and rock sole > flathead sole, or
- L** if flathead sole > other flatfish and flathead sole > rock sole, or
- F** if none of the three conditions above are met.

If target is not P, Y, R, L or F, then target is whichever species or species group (A, B, C, K, O, S, T) forms the largest part of the Total Catch.

Gulf of Alaska

- P** if Pollock $\geq 95\%$ of total catch, or
- W** if Arrowtooth flounder $\geq 65\%$ of total catch.

If target is not P or W, then target is whichever species or species group (A, B, C, D, H, K, L, O, S, X) forms the largest part of the Total Catch.

Table 2. Definition of Pacific halibut discard condition codes for trawl gear in 2001.

Excellent: Fish is alive, showing no stress, and injuries, if any, are slight.

1. External injuries.
 - *Superficial nicks or cuts on body.*
 - *Little (<10% of fin area) or no fraying of dorsal and anal fin.*
 - *Hemorrhaging (redness) of skin on white side limited to 5-10% of surface area.*
2. Operculum pressure.
 - *Fish is able to close operculum tightly for at least 5-10 seconds.*
3. Muscle tone and physical activity.
 - *Strong and lively, perhaps flopping around on deck if provoked.*
 - *Fish can tightly clench its jaw.*
4. Bleeding.
 - *No bleeding observed.*
5. Gills and gill color.
 - *Deep red in color.*

Poor: Fish is alive, but showing signs of stress.

1. Injuries are apparent.
 - *Body abrasions have damaged the skin but skin is still present, not missing.*
 - *Cuts and lacerations in body extend through skin just into flesh and are not deep.*
 - *Between 10 and 50% of dorsal and anal fins are frayed.*
 - *Slight bleeding from fin edges.*
 - *Approximately 10-25% of skin on white side of fish shows hemorrhaging.*
2. Operculum pressure.
 - *Fish closes operculum weakly and not sustained.*
3. Muscle tone or physical activity.
 - *Weak, intermittent movement. May respond if stimulated or provoked.*
 - *Body is limp, but not in rigor mortis.*
4. Bleeding.
 - *Blood is continually flowing from gills, but not profusely.*
5. Gills and gill color.
 - *Deep to bright red in color.*

Dead: No sign of life or, if alive, likely to die from severe injuries or suffocation.

1. Injuries are apparent.
 - *Body cavity ripped open.*
 - *Internal organs exposed and damaged.*
 - *Cuts and lacerations in body extend deeply into the flesh.*
 - *Sediment in mouth.*
 - *Hemorrhaging in skin on 25% or more of white side.*
2. Operculum pressure.
 - *Fish does not close operculum.*
3. Muscle tone and physical activity.
 - *No sign of muscle tone (limp) or fish is in rigor (stiff).*
 - *Physical activity absent or limited to fin ripples or twitches.*
 - *Little, if any, response to stimuli.*
 - *Jaw is hanging open.*
4. Bleeding.
 - *Blood is flowing freely and continuously in large quantity from a torn or severed gill arch, or a body injury.*
5. Gills and gill color.
 - *Gills appear washed out, e.g., dull red, pink, or white in color.*

Table 3. Definition of Pacific halibut discard condition codes for hook-and-line gear in 2001.

Minor injuries: Injuries, if any, are slight and inconsequential to health of the fish.

1. Injuries around the mouth from the hook and hook removal are slight.
 - *A hook entrance/exit hole around the jaw or in the cheek.*
 - *The lip (skin covering the external portion of the jaw) may be torn and hanging.*
 - *The hook and some length of residual gangion may be hanging from the mouth if the gangion was cut.*
2. Very little bleeding, if any.
 - *Bleeding is seen only in the area surrounding the jaw.*
 - *Bleeding may have stopped, or may be continuing very slowly a few drops at a time.*
3. No penetration of the body or head by sand fleas.
 - *Membranes surrounding eyes and anus are intact, without any holes from sand fleas.*
 - *A few sand fleas may be seen on body and can be wiped off with your hand. Typically, no penetration has occurred when only a few (e.g., <10) sand fleas are found on the body.*

Moderate injuries: Injuries are present, but are not severe.

1. Injuries may have been inflicted to the jaw, cheek, eye, or body.
 - *Lower jaw may be broken into 2 pieces at the snout, but each is still attached at the base of the jaw.*
 - *Jaw is torn on one side or the other, possibly extending through the cheek.*
 - *Hook may have punctured the eye or eye socket.*
 - *Wounds on head and abdomen limited to surface scratches on skin.*
 - *No wounds of any kind to abdominal organs. Abdominal cavity wall not punctured.*
 - *Wounds in body consist of puncture holes in skin, with possibly a flesh tear.*
2. Bleeding is occurring but not from gills.
 - *Blood may be seen around mouth and jaw.*
 - *Blood is not flowing profusely, but is oozing continuously.*
3. No penetration of the body or head by sand fleas.
 - *Membranes surrounding eyes and anus are intact, without any holes from sand fleas.*
 - *A few sand fleas may be seen on body and can be wiped off with your hand. Typically, no penetration has occurred when only a few (e.g., <10) sand fleas are found on the body.*

Severe injuries: Severe life-threatening injuries can be seen.

1. Injuries to the head and/or jaw have occurred. Any of the following will be present, individually or in combination:
 - *Skin on head (forward of preopercle) is ripped and torn deeply, exposing tissue and internal organs.*
 - *Side of the head, possibly including the jaw, has been torn loose and missing from the fish.*
 - *Lower jaw has been torn away and is missing.*
 - *No wounds of any kind to abdominal organs. Abdominal cavity wall not punctured.*
2. No penetration of the body or head by sand fleas.
 - *Membranes surrounding eyes and anus are intact, without any holes from sand fleas.*
 - *A few sand fleas may be seen on body and can be wiped off with your hand. Typically, no penetration has occurred when only a few (e.g., <10) sand fleas are found on the body.*

(cont'd)

Table 3. (cont'd) Definition of Pacific halibut discard injury codes for hook-and-line gear in 2001.

Dead/Fleas/Bleeding: Fish is lifeless, sand flea predation, excessive bleeding

1. Fish is already dead when brought to the surface on the gear
 - *Fish is in rigor and lifeless, even if no apparent injuries.*
 - *Gills appear completely devoid of blood (light pink or white in color).*
2. Marine mammals have taken bites out of the fish
 - *Usually taken out of the back of the fish or from the abdominal cavity.*
3. Sand fleas have penetrated the body via the eyes, fins, or anus.
 - *Membrane surrounding eye may be partially or completely missing.*
 - *Dorsal and/or anal fin membranes may be eaten away, leaving fin rays exposed. Skin on the body is separated from tissue where sand fleas have eaten.*
4. Bleeding is excessive, especially from the gills.
 - *Blood is flowing freely and continuously in large quantity.*
 - *Bleeding is occurring from a torn or severed gill arch.*
5. Internal organs are damaged, possibly by a gaff.
 - *Abdominal cavity wall is punctured or torn.*
 - *Viscera are visible and exposed, and may be protruding.*

Table 4. Definition of Pacific halibut discard condition codes for pot gear in 2001.

Excellent: Fish is alive, showing no stress, and injuries, if any, are slight.

1. External injuries.
 - *Superficial nicks or cuts on body.*
 - *Little (<10% of fin area) or no fraying of dorsal and anal fins.*
 - *Hemorrhaging (redness) of skin on white side limited to 5-10% of surface area.*
2. Operculum pressure.
 - *Fish is able to close operculum tightly for at least 5-10 seconds.*
3. Muscle tone and physical activity.
 - *Strong and lively, perhaps flopping around on deck if stimulated.*
 - *Fish can tightly clench its jaw.*
4. Bleeding.
 - *No bleeding from gills, body, or fins observed.*
5. Gills and gill color.
 - *Deep red in color.*
6. No penetration of the body or head by sand fleas. No predation by crabs.
 - *Membranes surrounding eyes and anus are intact, without any holes from sand fleas.*
 - *A few sand fleas may be seen on body, but can be wiped off with your hand. Typically, no penetration has occurred when only a few (e.g., <10) sand fleas are found on the body.*

Poor: Fish is alive, but displaying physical injuries and signs of stress.

1. External injuries are apparent.
 - *Body abrasions have damaged the skin but skin is still present, not missing.*
 - *Cuts and lacerations in body extend through skin just into flesh and are not deep.*
 - *Between 10 and 50% of dorsal and anal fins are frayed.*
 - *Slight bleeding from fin edges.*
 - *Approximately 10-25% of skin on white side of fish shows hemorrhaging.*
2. Operculum pressure.
 - *Fish closes operculum weakly and not sustained.*
3. Muscle tone or physical activity is weak.
 - *Intermittent body movement. May respond if stimulated.*
 - *Body appears limp, but not in rigor mortis.*
4. Bleeding.
 - *Blood is not flowing profusely, but is oozing continuously from fin edges or body wounds.*
5. Gills and gill color.
 - *Gills are deep to bright red.*
6. No penetration of the body or head by sand fleas. No crab predation.
 - *Membranes surrounding eyes and anus are intact, without any holes from sand fleas.*
 - *A few sand fleas may be seen on body, but can be wiped off with your hand. Typically, no penetration has occurred when only a few (e.g., <10) sand fleas are found on the body.*
 - *No damage to the fish from crabs, if any, in the pot.*

(cont'd)

Table 4. (cont'd) Definition of Pacific halibut discard condition codes for pot gear in 2001.

Dead/Fleas: No sign of life or, if alive, likely to die from injuries or predation.

1. External and internal injuries.
 - *Body cavity may be ripped open.*
 - *Internal organs may be exposed and damaged.*
 - *Body tissue may be torn or ripped in a rough, ragged manner.*
 - *Hemorrhaging in skin on 25% or more of white side.*
2. Operculum pressure.
 - *Fish does not close operculum.*
3. Muscle tone and physical activity.
 - *No sign of muscle tone (limp) or fish is in rigor (stiff)*
 - *Physical activity absent or limited to fin ripples or twitches.*
 - *Little, if any, response to stimuli.*
 - *Jaw may be open and slack.*
4. Bleeding.
 - *Blood is flowing profusely from fin edges or body.*
5. Gills and gill color.
 - *Gills appear washed out, e.g., dull red, pink, or white in color.*
6. Sand fleas have penetrated the body via the eyes, fins, or anus. Crab predation may also occur.
 - *Membrane surrounding eye may be partially or completely eaten by sand fleas.*
 - *Dorsal and/or anal fin membranes may be eaten away, leaving fin rays exposed. Skin on the body is separated from tissue where sand fleas have eaten.*
 - *Crabs in the pot may also have attacked and eaten the "dead" fish.*

Table 5. Information on observer coverage, sampling, and size composition of the halibut bycatch in 2001.

Area/Gear /Target	No. of Vsls Observed	No. of Smpld hauls	No. of fish measured	Mean Length (cm)	Percent <65 cm	Percent < 82 cm
<i>BSAI Longline</i>						
Pacific cod	39	1,107	20,296	67.7	0.471	0.848
Other sp.	6	24	138	72.9	0.316	0.658
Turbot	8	108	92	98.0	0.167	0.208
<i>BSAI Pot</i>						
Pacific cod	53	203	681	67.7	0.429	0.877
<i>BSAI Trawl</i>						
Atka mackerel	9	397	73	84.0	0.310	0.535
Bottom pollock	90	569	2,834	63.1	0.555	0.828
Pacific cod	76	486	4,356	55.5	0.768	0.938
Other flatfish	21	294	467	63.9	0.609	0.861
Rockfish	12	102	72	80.6	0.229	0.639
Flathead sole	20	567	1,034	69.4	0.429	0.807
Other sp.	8	16	56	66.5	0.585	0.902
Pelagic pollock	100	1,233	14,170	67.6	0.456	0.768
Rock sole	20	532	2,593	52.6	0.766	0.905
Turbot	7	119	71	73.2	0.259	0.698
Yellowfin sole	25	918	2,101	72.0	0.421	0.676
<i>GOA Longline</i>						
Pacific cod	11	163	617	68.0	0.443	0.845
<i>GOA Pot</i>						
Pacific cod	21	117	501	73.4	0.242	0.738
<i>GOA Trawl</i>						
Bottom pollock	53	100	856	63.6	0.612	0.834
Pacific cod	55	237	3,458	58.9	0.702	0.892
Dp wtr flatfish	6	50	158	80.7	0.258	0.558
Shall wtr flatfish	30	94	2,167	54.2	0.732	0.891
Rockfish	45	324	1,174	84.7	0.171	0.482
Flathead sole	9	78	439	63.3	0.644	0.876
Other sp.	4	24	73	63.0	0.667	0.899
Pelagic pollock	40	75	74	76.5	0.306	0.592
Sablefish	3	14	17	83.6	0.037	0.444
Arrowtooth flndr	9	154	443	68.2	0.457	0.844
Rex sole	7	142	322	67.4	0.459	0.894

Table 6. Distribution of halibut viability data by condition factor and target fishery during 2001.

Target	Raw Data				Extrapolated Data				
	Exc	Poor	Dead	DMR	Exc	Poor	Dead	DMR	SE
<i>BSAI Trawl</i>									
Atka mackerel	29	6	38	0.593	953	53	2,965	0.727	0.0953
Bottom pollock	238	291	2,305	0.805	3,486	4,430	17,283	0.742	0.0458
Pacific cod	918	1,223	2,215	0.654	13,504	19,472	45,245	0.692	0.0422
Other flatfish	68	56	343	0.756	2,176	2,196	22,228	0.814	0.1484
Rockfish	9	10	53	0.764	79	304	2,673	0.847	0.2060
Flathead sole	146	436	452	0.654	3,310	9,843	14,213	0.689	0.0953
Other sp.	7	39	10	0.569	18	826	36	0.557	0.1228
Pelagic pollock	92	147	13,931	0.892	181	371	30,595	0.892	0.0103
Rock sole	281	722	1,590	0.727	7,627	23,128	71,452	0.769	0.0372
Turbot	3	48	20	0.634	70	914	680	0.678	0.1399
Yellowfin sole	318	403	1,380	0.727	10,276	12,647	51,108	0.743	0.0593
<i>BSAI Pot</i>									
Pacific cod	638	24	19	0.063	1,524	59	39	0.061	0.0876
Sablefish	6	2	1	0.333	10	4	1	0.333	0.1348
<i>GOA Trawl</i>									
Bottom pollock	318	124	414	0.589	2,374	2,015	3,019	0.580	0.0784
Pacific cod	1,101	894	1,463	0.587	17,143	19,291	44,193	0.667	0.0574
Deepwater flatfish	60	46	52	0.532	807	370	508	0.488	0.1682
Shallow water flatfish	609	454	1,104	0.630	16,323	12,469	28,317	0.624	0.0715
Rockfish	484	182	508	0.557	7,085	3,628	10,923	0.612	0.0959
Flathead sole	158	97	184	0.571	2,156	2,049	5,684	0.675	0.1288
Other sp.	22	18	33	0.603	508	367	807	0.612	0.2223
Pelagic pollock	1	0	73	0.891	1	0	74	0.891	0.1124
Sablefish	6	1	10	0.632	21	8	46	0.664	0.1952
Arrowtooth flounder	45	40	358	0.797	952	1,551	27,702	0.860	0.2621
Rex sole	90	77	155	0.621	2,075	1,798	3,457	0.616	0.1441
<i>GOA Pot</i>									
Pacific cod	354	99	48	0.293	715	245	102	0.327	0.1156

Target	Raw Data					Extrapolated Data					
	Minor	Mod	Severe	Dead	DMR	Minor	Mod	Severe	Dead	DMR	SE
<i>BSAI Longline</i>											
Pacific cod	16,632	2,487	556	621	0.122	316,849	44,482	9,990	11,365	0.118	0.0121
Rockfish	14	4	0	0	0.108	364	81	0	0	0.095	0.0421
Other sp.	109	19	5	5	0.138	2,320	383	61	178	0.149	0.0475
Turbot	83	6	0	3	0.088	1,411	56	0	21	0.061	0.0449
<i>GOA Longline</i>											
Pacific cod	538	71	8	14	0.101	20,210	3,566	264	586	0.112	0.0492
Other sp.	33	3	4	1	0.144	537	76	99	5	0.163	0.2268

Table 7. Observer coverage and halibut viability/injury data collected from the 2001 Bering Sea/Aleutian CDQ fishery.

			Raw Data					Ext. data					
	#	# of	Exc/	Poor/	Dead/			Exc/	Poor/	Dead/			
Target	Vessels	Hauls	Minor	Mod.	Sev,	Dead	DMR	Minor	Mod	Sev.	Dead	DMR	SE
CDQ Longline													
P cod	17	618	1,989	229	49	56	0.104	28,934	3,511	997	671	0.106	0.0163
O sp.	4	22	22	0	0	2	0.115	250	0	0	26	0.126	0.0865
Sable	1	59	6	3	0	2	0.300	31	17	0	11	0.312	0.0000
CDQ Pot													
P cod	1	34	46	1	4	-	0.098	28	0	1	-	0.023	0.0000
Sable	3	73	24	3	33	-	0.600	46	3	36	-	0.456	0.3376
CDQ Trawl													
Atka m.	3	170	4	6	47	-	0.814	30	138	521	-	0.800	0.3039
B poll	1	6	0	0	15	-	0.900	0	0	23	-	0.900	0.0000
O flats	1	15	3	0	24	-	0.822	25	0	261	-	0.839	0.0000
Flthd s	1	4	0	0	3	-	0.900	0	0	47	-	0.900	0.0000
P poll	12	721	20	9	1,644	-	0.890	36	13	4,716	-	0.894	0.0044
Rckfsh	1	9	0	0	36	-	0.900	0	0	619	-	0.900	--

Table 8. Summary of halibut discard mortality rates (DMRs) in the Bering Sea/Aleutian Islands (BSAI) groundfish fisheries during 1990-2001. DMRs used in 2002 are to be used in 2003.

Gear/Target	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	Used in 2002¹
<i>BSAI Trawl</i>													
Atka mackerel	66	77	71	69	73	73	83	85	77	81	77	73	75
Bottom pollock	68	74	78	78	80	73	79	72	80	74	67	74	76
Pacific cod	68	64	69	67	64	71	70	67	66	69	69	69	67
Other Flatfish	80	75	76	69	61	68	67	71	78	63	76	81	71
Rockfish	65	67	69	69	75	68	72	71	56	81	89	85	69
Flathead sole	-	-	-	-	67	62	66	57	70	79	74	69	67
Pelagic pollock	85	82	85	85	80	79	83	87	86	87	88	89	84
Rock sole	64	79	78	76	76	73	74	77	79	81	75	77	76
Sablefish	46	66	-	26	20	-	-	-	-	90	60	-	50
Turbot	69	55	-	-	58	75	70	75	86	70	74	68	70
Yellowfin sole	83	88	83	80	81	77	76	80	82	78	77	74	81
<i>BSAI Pot</i>													
Pacific cod	12	4	12	4	10	10	7	4	13	9	13	6	8
<i>BSAI Longline</i>													
Pacific cod	19	23	21	17	15	14	12	11	11	12	12	12	12
Rockfish	17	55	-	6	23	-	20	4	52	-	12	10	25
Sablefish	14	32	14	13	38	-	-	-	-	-	-	-	22
Turbot	15	30	11	10	14	9	15	22	18	17	14	6	18
<i>CDQ Trawl</i>													
Atka mackerel	-	-	-	-	-	-	-	-	-	82	89	80	82
Bottom pollock	-	-	-	-	-	-	-	-	90	88	90	90	88
Flathead sole	-	-	-	-	-	-	-	-	-	-	83	90	79
Pelagic pollock	-	-	-	-	-	-	-	-	90	90	88	89	90
Rockfish	-	-	-	-	-	-	-	-	-	88	-	90	88
Yellowfin sole	-	-	-	-	-	-	-	-	-	83	-	-	83
<i>CDQ Longline</i>													
Pacific cod	-	-	-	-	-	-	-	-	10	10	13	11	10
Turbot	-	-	-	-	-	-	-	-	-	-	4	-	17
<i>CDQ Pot</i>													
Pacific cod	-	-	-	-	-	-	-	-	-	-	7	2	9
Sablefish	-	-	-	-	-	-	-	-	-	-	38	46	12

¹Values represent 1990-1999 long term mean.

Table 9. Summary of halibut discard mortality rates (DMRs) in the Gulf of Alaska (GOA) groundfish fisheries during 1990-2001. DMRs used in 2002 are to be used in 2003.

Gear/Target	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	Used in 2002¹
<i>Trawl</i>													
Atka mackerel	67	89	81	67	53	-	60	-	-	-	-	-	70
Bottom pollock	51	62	66	57	48	66	79	66	55	55	52	58	61
Pacific cod	60	62	66	59	53	64	70	62	64	54	57	67	61
Deep wtr flats	61	58	70	59	60	56	71	61	51	51	62	49	60
Shallow wtr flats	66	71	69	65	62	70	71	71	67	81	67	62	69
Rockfish	65	75	79	75	58	71	65	63	68	74	71	61	69
Flathead sole	-	-	-	-	54	64	67	74	39	51	69	68	58
Pelagic pollock	71	82	72	63	61	51	81	70	80	86	80	89	72
Sablefish	70	60	68	59	67	58	80	61	-	68	38	66	66
Arrowtooth flldr	-	-	-	-	-	-	66	48	62	73	75	86	62
Rex sole	-	-	-	-	56	76	63	47	58	70	71	62	61
<i>Pot</i>													
Pacific cod	12	7	16	24	17	21	7	11	16	13	8	33	14
<i>Longline</i>													
Pacific cod	15	18	13	7	11	13	11	22	11	17	16	11	14
Rockfish	6	-	-	7	-	4	13	-	9	-	9	-	8
Sablefish	17	27	28	30	22	-	-	-	-	-	-	-	24

¹Values represent 1990-1999 long term mean.